

CHAPTER 6

PERFORMANCE DATA ANALYSIS

This chapter presents performance data associated with the various fabricare cleaning alternatives. The information and data focus primarily on the factors that affect the ability of a process to clean garments effectively.

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Section 6.1 summarizes relevant performance assessment criteria for comparing alternative clothes cleaning processes. Section 6.2 includes a study-by-study presentation of garment and fabricare performance data associated with drycleaning and wetcleaning cleaning technologies. The performance data summarized include the results from clothes cleaning demonstrations and laboratory studies performed in the United States and Canada.

The studies range in scope and complexity, but are generally limited to comparisons of the drycleaning (perchloroethylene [PCE] and hydrocarbon [HC] solvent based) and machine wetcleaning cleaning options. Although improved HC solvents with lower flash points are included in one study in progress, the results were not available at the time of publication. Because the information collected in these studies varies widely, performance results are presented in the format chosen by the study author(s). No further analysis of study data was performed independently to verify results or conclusions. In addition, individual studies may contain specific limitations that are not necessarily identified in this chapter. Due to the wide variability in potential operating conditions, the performance studies summarized in this chapter represent case studies rather than generalizable scenarios.

6.1 PERFORMANCE EVALUATION OF PROFESSIONAL FABRICARE

The Cleaner Technologies Substitutes Assessment (CTSA) has identified various qualitative and quantitative criteria to assist stakeholders in evaluating a fabricare process. This information has been compiled through a review of literature pertaining to performance-based studies of fabricare process options. **When evaluating cleaning performance, it is important to note that variations in technology and the knowledge base of operators will cause a range of results (Blackler et al., 1995).**¹ Although many of the criteria mentioned below are used in the performance-based studies discussed in Section 6.2, they are not universally applied or accepted by the public and private sectors. In addition, other performance considerations may become apparent as clothes cleaning studies expand to include additional alternative technologies.

¹In any industry there is a performance learning curve, which is inherent with the use of “cutting-edge” technology. The fabricare industry is no different in this case; the effective cleaning performance and financial viability associated with using innovative fabricare methods, other than drycleaning, will inevitably increase with time. Enhancements in equipment technology, detergents, clothing manufacturing, and care labeling practices are all likely to influence the use, acceptance, and therefore success of innovative cleaning methods by the industry and its customers. Such changes are likely to positively affect traditional drycleaning methods as well (Adamson, 1998; Riggs, 1998).

6.1.1 Performance Assessment Protocol

Consensus protocols for comparing the performance of fabricare options have been under review for several years by a number of public and private organizations. Drycleaning quality control standards have been established by the International Fabricare Institute (IFI). The American Association of Textile Chemists and Colorists (AATCC) also has developed historical criteria for “troubleshooting” drycleaning problems and test methods for standard soil and fabric combinations (Patton, 1994). In addition, the following organizations provide evaluation services for standard soil/fabric combinations: IFI (United States), Krefeld Research Institute for Cleaning Technology (WFK - Germany), Cleaning Techniques Research Institute (TNO - Netherlands), Hohenstein Institute (Germany), and the International Wool Secretariat (England) (Riggs, 1996).

The American Society for Testing and Materials (ASTM) and AATCC have developed performance specifications and test methods, respectively, for acceptable dimensional change (shrinkage and stretching) after laundering and drycleaning (CNT, 1996). These standards assist clothing manufacturers in establishing some consistency in their care labeling instructions. In general, the maximum allowable shrinkage is 2% after three drycleanings and 3% after five launderings (CNT, 1996).

Textile scientists affiliated with AATCC and ASTM have developed performance criteria regarding colorfastness, soil removal, odor, fiber damage, shrinkage, and hand (fabric texture). These standards, listed in volume 7.01 of the *Annual Book of ASTM Standards* (ASTM, 1998) are linked to care labeling guidelines currently under revision by these organizations. Such standards will inevitably affect specifications for soap and detergents, as well as clothes cleaning equipment.

The European Wetcleaning Committee (EWCC), a consortium of research institutes, machine and system manufacturers, detergent suppliers, and organizations with technical expertise, has performed a study to develop a test method for wetcleaning. The EWCC hopes that the combined results of the study and a second series of tests will provide data adequate to establish consensus guidelines for wetcleaning care labels (den Otter, 1996).

6.1.2 Subjective Measures of Cleaning Performance

Numerous studies included in this chapter take advantage of customer mail and telephone surveys to measure customer satisfaction, as a surrogate measure of cleaning process performance. In some instances, researchers have performed parallel surveys to compare customer perceptions of the cleaning performance of two separate process options (e.g., dry versus wetcleaning). Customer surveys are a subjective measure of cleaning performance because they record customers' perceptions of how “clean” their garments are as a result of using a particular technology. Researchers note that customer perceptions of a clean garment may vary due to regional, socioeconomic, and cultural differences. Variations in acceptable cleaning performance and pricing levels are noted among European, Canadian, and American consumers (Adamson, 1996). Other researchers note that the cultural differences may affect how many times a garment is worn prior to re-cleaning, rather than how “clean” a garment must be for it to be acceptable to a consumer (Riggs, 1998).

6.1.3 Physical and Chemical Characteristics of Clothes Cleaning

All professional clothes cleaning technology should strive to achieve the following goals (Wentz, 1994; Hohenstein, undated):

- Optimize soil removal by overcoming the physical and chemical forces that bind soils to textiles;
- Transport soils away from the textile through the cleaning medium; and
- Preserve and/or restore the original attributes of textiles, including dimensions, dye character, hand, and overall fabric finish.

The cleaning ability of a process depends on the following factors: (1) soil chemistry, (2) textile fiber type, (3) transport medium (aqueous vs. non-aqueous), (4) chemistry of additives (detergents, surfactants), (5) use of spotting agents, and (6) process controls (time, temperature, and mechanical actions). These factors work interactively to provide a range of cleaning abilities for all clothes cleaning processes.

In general, non-aqueous (solvent-based) cleaning processes are effective in dissolving non-polar soils (e.g., oils, fatty stains). Aqueous (water-based) cleaning processes tend to dissolve polar soils (e.g., sugar, salt, perspiration) with greater success. Neither process type removes particulate soils significantly better than the other (Wentz, 1996). However, the cleaning ability of a particular process option may be enhanced with the use of spotting agents, alternative detergents, surfactant additives, and other process modifications such as cleaning time, temperature, or mechanical action.

Non-aqueous cleaning processes are most effectively used with textiles that contain hydrophilic fibers, low-twist yarns, low-count fabrics, and polar colorants. Aqueous cleaning processes are effective with textiles containing hydrophobic fibers, high-twist yarns, high-count fabrics, and non-polar colorants (Wentz, 1996).

Water-based cleaning methods tend to cause expansion of natural and cellulose fibers, leading to a loss of strength, wrinkling, color loss, and dimensional change (shrinkage, stretching). However, such alterations are not necessarily apparent when synthetic fibers are subjected to similar water-based cleaning methods. Textile manufacturers have developed a number of fiber treatments and modifications that may minimize such alterations. For synthetic fibers, non-aqueous cleaning methods may not be appropriate due to potential fiber deterioration (Wentz, 1996).

Other process characteristics that affect cleaning performance include detergent type, mechanical action of equipment, cleaning time, and temperature of cleaning medium. Such characteristics affect not only soil and stain removal, but also potential damage to garments. These individual factors vary in importance according to the cleaning method (Hohenstein, undated).

Pre-treatment and post-treatment spotting is often necessary, regardless of the cleaning method chosen. Spotting agents can be brushed, sprayed, or dripped onto clothing prior to final rinsing and are chosen based on the chemical nature of the target soils. The choice of spotting agent and the application procedure are important considerations because they can cause color changes and dye transfers (Hohenstein, undated).

Another factor in the success of a particular fabricare process is the skill and experience of the clothes cleaning operators. Their ability to properly sort garments and to choose the appropriate process conditions, as well as their knowledge of textiles and cleaning processes, will have a decisive influence on the success of a particular cleaning method. Clothes cleaning operators can also prevent potential damage to garments by being aware of adverse interactions between textiles and cleaning methods (Wentz, 1996). As indicated previously, the ability of cleaning processes to successfully remove soils from a variety of textiles occurs within a range. Because human skill affects that range, textile properties alone cannot be used as a strict guideline for evaluating the ability of a cleaning process (Wentz, 1996; Blackler et al., 1995).

6.1.4 Clothes Cleaning and Textile Damage Potential

Textile damage during cleaning processes includes dimensional change (shrinkage and stretching), appearance change (color loss, dye transfer, damage to decorative trim), tears (mechanical action), and tactile change (garment texture) (Wentz, 1996; Hohenstein, undated). Mechanisms of garment shrinkage include felting (the increase in differential friction between wool fibers caused by swelling in water) and relaxation (the release of microscopic and macroscopic fiber stress via mechanical action, swelling in liquid media, or excessive heat). Relaxation shrinkage, also called progressive shrinkage, is unavoidable in most textiles after multiple cleanings, regardless of the cleaning methodology (Wentz, 1996).

The ability of a fabricare process to maintain the visual (color, finish) and tactile (texture) appearance of a garment is equally important when considering cleaning performance. Restoration of the physical properties of a garment is a function of the cleaning method, textile properties, and the expertise of the operator. In the case of both aqueous and non-aqueous cleaning methods, fabric finishes may be necessary to restore and improve the feel of a garment's texture (hand). Careful sorting, the use of process additives that protect garment fibers, and careful attention to process conditions and their effect on specific clothing types can mitigate garment damage (Hohenstein, undated).

6.2 REVIEW OF PERFORMANCE STUDIES FOR FABRICARE OPTIONS

6.2.1 Summary of Findings

This chapter has identified laboratory-based and “real world” demonstration studies, both of which are a necessary component of performance evaluation for alternative clothes cleaning processes. Although there are many fabricare technologies under development by manufacturers, the performance assessments identified in this chapter focus entirely on machine wetcleaning as an alternative to non-aqueous based methods. Results of the machine wetcleaning performance studies included here should be considered preliminary due to a lack of uniform performance assessment protocols.

Given the limited number of performance studies available for comparing alternative clothes cleaning options, it is difficult to draw conclusions. The variations associated with clothing fibers and soils result in performance differences for all process options considered. A number of studies mention that the skill of the cleaners follows a distinct learning curve, resulting in greater performance as they adapt to new technology. For example, the *Cleaner by Nature* (UCLA/Occidental/PPEREC) study mentioned that their redo rate increased when there was turnover in their cleaner and presser positions

(Gottlieb et al., 1997). Greater use of these cutting-edge technologies in the fabricare industry will inevitably result in advancements in equipment design and operator skills, therefore resulting in increased cleaning performance (Gottlieb et al., 1997; Riggs, 1998; Adamson, 1998).

Most researchers agree that many garments labeled “dryclean only” can be effectively wetcleaned. The results from *The Greener Cleaner*, *Cleaner by Nature*, and other ongoing demonstration studies indicate that the cleaning performance associated with modern wetcleaning equipment makes this technology an acceptable substitute for a significant fraction of consumer garments. There continues to be debate as to the actual percentage of clothing types traditionally labeled “dryclean only” by manufacturers that can be safely and effectively wetcleaned. Researchers note that the debate should focus not necessarily on percentages of clothing, but on the types of clothing and fabrics that can be successfully wetcleaned (Adamson, 1998; Riggs, 1998).

Based solely on customer claims, one could argue that 99% of all garments can be wetcleaned. However, when an evaluation factor (i.e., a customer satisfaction survey) is introduced, the percentage drops to 93% (CNT - Overall was your clothing clean?), 95% (Environment Canada - Will you use the cleaner again?), and 93% (UCLA/Occidental/PPEREC - overall customer rating of excellent or good). If one considers the results of expert panel evaluations of garments wetcleaned multiple times, the percentage is lowered to 83% (UCLA/Occidental/PPEREC)² and 63% (CNT). In reporting such findings from these studies, it is important to consider that there may be differences between garments that have been wetcleaned, and those that are wetcleaned effectively, to the satisfaction of the customer. Other study variables noted to affect the feasibility of wetcleaning in professional fabricare operations include cleaning costs, garment sample size, garment type, and operator skill.³

Additional financial analysis, in conjunction with performance assessment, is necessary to determine the feasibility of using the alternative technologies in the professional clothes cleaning market. Although the clothes cleaning customer is an important arbiter for deciding the effectiveness of a garment care option, fabricare operators must also consider the cost effectiveness of each process option. The competitive nature of the fabricare industry demands that both traditional and innovative technologies be cost-competitive, regardless of their ability to clean garments to the satisfaction of customers. Future work related to performance of cleaning operations should focus on technology cost assessment studies, in addition to the development of consensus testing and evaluation protocols. An ongoing U.S. Environmental Protection Agency (USEPA) laboratory study is expected to aid in the development of the latter information (Riggs, 1998).

Cleaning performance data from several comparative clothes cleaning studies are presented in the following section. Performance assessment techniques include customer satisfaction surveys, evaluation

²The percentage of drycleaned garments whose appearance was deemed acceptable is 87.5%.

³Modern wetcleaning is new to the professional fabricare industry, compared to drycleaning with PCE or HC solvents. Several factors may influence the performance of this and other innovative technologies in comparison studies: (1) operator inexperience, (2) relative immaturity of the equipment, (3) fabric and dye incompatibility, and (4) garment labeling biases (Gottlieb et al., 1997). In particular, operator skill is consistently cited as an important factor in improving the success of wetcleaning in the studies included in this chapter (Adamson, 1998). The fabricare industry is currently working with government regulators, garment and fabric manufacturers, and equipment manufacturers to resolve these issues in a manner that is beneficial for all stakeholders (Riggs, 1998).

of cleaned garments and fabric swatches by industry experts, and analysis of repeatedly cleaned and damaged garments. Each study summary includes general project information, results indicated or expected, and additional results provided by researchers.

6.2.2 Alternative Clothes Cleaning Demonstration Shop (*The Greener Cleaner*) - Draft Final Report (September 1996)

Sponsor: USEPA
Investigating Organization: Center for Neighborhood Technology (CNT)
Duration of Study: 12 months (May 1995 to May 1996)
Location: Chicago, Illinois
Source of Information: Center for Neighborhood Technology, 1996

Summary of Performance Evaluations

- Two customer satisfaction telephone surveys of customers of *The Greener Cleaner*
- Evaluation of a random sample of wetcleaned customer garments by *The Greener Cleaner*
- Evaluation of identical garments before and after wetcleaning and drycleaning
- Comparison of “old” clothing after multiple wet and drycleanings

Wetcleaning Demonstration Site

Between 1995 and 1996, CNT designed, monitored, and evaluated a machine wetcleaning shop, *The Greener Cleaner*. This shop was developed and operated to mimic a “typical” commercial drycleaning shop in terms of size, price, fabric types, and garments cleaned. Exhibit 6-1 is a demonstration profile for *The Greener Cleaner* operation. Using only wetcleaning equipment for this aspect of the study, CNT evaluated the costs and customer satisfaction associated with a range of typically drycleaned garments. Performance results for this part of the CNT study pertain to the 1 year the shop was operated as a demonstration site.

Exhibit 6-1. *The Greener Cleaner* Demonstration Shop Profile

<i>Description</i>	Retail garment cleaning operation, plant on premises, 100% wetcleaning		
<i>Location</i>	5312 North Broadway, Chicago; mini-mall shopping plaza		
<i>Shop Size</i>	1250 sq. ft.		
<i>Personnel</i>	Noam Frankel (owner) Ann Hargrove (plant manager) 1 to 2 pressers (full-time equivalent) 2 to 3 counter personnel (full-time equivalent)		
<i>Cleaning/Drying</i>	Wascomat/Aqua Clean ACS50G (50 lb. washer and 30 lb. gas-heated dryer)		
<i>Equipment</i>	Whirlpool domestic washing machine Drying cabinet		
<i>Pressing/Finishing Equipment</i>	Unipress utility press Unipress hot head press Cissell triple puff Cissell form finisher Veit pants topper Veit form finisher Veit ironing table		
<i>Cleaning Supplies for Wetcleaning Equipment</i>	Bufa Aquasafe Detergent Bufa Aquasafe Pre-Finish		
<i>Sample Price List</i>			
	Tie		\$3.00
	Pants		3.50
	2-piece wool suit		6.50
	Silk dress		7.50
	Full-length down coat		13.00
<i>Number of Garments Wetcleaned</i>	31,734	(60% labeled "dryclean only")	

Exhibits 6-2 and 6-3 describe the distribution of the fiber and garment types, respectively, cleaned during *The Greener Cleaner* demonstration. Blended fibers are recorded in terms of the dominant fiber or the fiber most difficult to clean. Clothes were cleaned between May 11, 1995, and May 11, 1996. The report recognizes that regional and seasonal variations make it difficult to develop a "typical" sample of garments that includes an industry-wide representation of fiber types, fabrics, and garment types. The shop accepted virtually all garments for cleaning regardless of the instructions on the care label. During the duration of this study, 43 garments (0.14%) were rejected for machine wetcleaning if the shop employees felt they would not be able to clean them successfully. The shop fully guaranteed its work and reimbursed customers for the few damaged garments. Claims were paid on 28 (0.08%) of the total garments cleaned, which included 9 lost garments, 10 garments with shrinkage, 3 garments with color loss or fading, 1 garment with a burn from pressing, 1 garment with unresolved spotting problems, and 4 garments with miscellaneous or unreported problems.

Exhibit 6-2. Fiber Types Machine Wetcleaned at *The Greener Cleaner*

Fiber Type	Number Cleaned	% of Total
Wool	7,341	23%
Rayon	6,468	20%
Cotton	5,117	16%
Silk	3,532	11%
Linen	1,984	6%
Polyester	199	1%
Down	221	1%
Unknown	6,872	22%
Total	31,734	100%

Exhibit 6-3. Garment Types Machine Wetcleaned at *The Greener Cleaner*

Garment Type	Number Cleaned	% of Total
Suit	2,715	9%
Pants	6,766	21%
Blazer/jacket	2,783	9%
Vest	517	2%
Shirt	2,673	8%
Blouse	4,363	14%
Skirt	1,924	6%
Dress	2,372	7%
Scarf	280	1%
Outerwear	1,416	4%
Sweater	3,403	11%
Home items	589	2%
Tie	355	1%
Misc.	1,578	5%
Total	31,734	100%

Results of Customer Satisfaction Survey

Two independent surveys were performed by Audits and Surveys Worldwide, Inc. During November 1995, 203 of the 1,800 customers of *The Greener Cleaner* were randomly chosen for telephone interviews. Eighty-five percent of these individuals rated the shop's performance as either "good" or "excellent." In June 1996, 100 of the 2,868 shop customers were randomly chosen for the same survey. Eighty-seven percent of these individuals rated the shop's overall service as "good" or "excellent," and 84% said they would recommend the service to a friend. The second survey indicated that 64% of the customers used *The Greener Cleaner* as a result of their concern for the environment. The questions and the results of both surveys are listed below in Exhibit 6-4.

Exhibit 6-4. Telephone Survey Questions and Results

Survey Question	Response	November 1995	June 1996
1. How would you rate their service overall ?	Excellent Good Acceptable Poor Don't know/refused	41.0% 45.0% 6.5% 6.5% 1.0%	48.5% 38.5% 8.0% 4.0% 1.0%
2. How would you rate their counter service overall?	Excellent Good Acceptable Poor Don't know/refused	49.0% 42.0% 7.0% 1.5% 0.5%	48.5% 40.5% 9.0% 2.0% 0.0%
3. After being serviced by <i>The Greener Cleaner</i> , were your clothes pressed and finished nicely?	Yes No Don't know/refused	90% 9.0% 1.0%	88.0% 9.0% 3.0%
4. Was there any size difference?	Yes No Don't know/refused	14.0% 82.0% 4.0%	18.0% 82.0% 0.0%
4a. Would that be.....?	Shrinking Stretching Other	13.0% 1.0% 0.0%	15.0% 5.0% 1.0%
5. Did the seams pucker or bulge?	Yes No Not applicable Don't know/refused	7.0% 87.0% 1.0% 4.0%	5.0% 93.0% 1.0% 1.0%
6. Was there any odor present in your clothing?	Yes No Don't know/refused	3.0% 96.5% 0.5%	1.0% 99.0% 0.0%
6a. If odor was present, was this odor acceptable or unacceptable?	Acceptable Unacceptable	1.5% 1.5%	1.0% 0.0%
7. Was there any color change to your clothing?	Yes No Don't know/refused	6.0% 92.0% 2.0%	1.0% 99.0% 0.0%

Exhibit 6-4. Telephone Survey Questions and Results (Cont'd)

7a. With regard to the color change was there....?	Overall change with improvement Overall change, no improvement Some unevenness in color Don't know/refused	0.0% 3.5% 2.0% 0.5%	0.0% 0.0% 1.0% 0.0%
8. Were stains or spots removed?	Yes No Not applicable/no spots or stains Don't know/refused	60.0% 14.0% 23.0% 3.0%	63.0% 15.0% 18.0% 4.0%
9. Were there any rips or tears?	Yes No Don't know/refused	2.0% 96.5% 1.5%	8.0% 91.0% 1.0%
10. If your clothing had any buttons or decorations were any...	Damaged Missing No problems/decorations Not applicable/no buttons or decorations Don't know/refused	3.5% 1.5% 59.0% 34.0% 2.0%	0.0% 3.0% 95.0% 3.0% 0.0%
11. Overall, was your clothing clean?	Yes No Don't know/refused	94.5% 5.5% 0.0%	93.0% 4.0% 3.0%
12. Would you recommend <i>The Greener Cleaner</i> to a friend?	Yes No Don't know/refused	85.0% 12.0% 3.0%	84.0% 12.0% 4.0%
13. Why did you first take your clothes to <i>The Greener Cleaner</i> ?	Convenient location/parking Concern about the environment Reputation for quality and service Curious Other Don't know/refused	Question not used in survey	18.0% 64.0% 11.0% 16.0% 14.0% 0.0%
14. Were you aware that the process used at <i>The Greener Cleaner</i> is water based, not the usual solvent-based process that is used to dryclean clothes?	Yes No Don't know/refused	Question not used in survey	87.0% 12.0% 4.0%
14a. How did you first react to hearing of the use of this water-based process?	Very positive Somewhat positive Neither positive or negative Somewhat negative Very negative Don't know/refused	Question not used in survey	61.0% 12.0% 12.0% 1.0% 0.0% 1.0%

Random Evaluation of Machine Wetcleaned Garments

A panel of 19 volunteers (one or two per evaluation) and a CNT engineer randomly selected 460 garments (108 knit, 352 woven) and evaluated them prior to and after washing by *The Greener Cleaner*. The volunteers included 12 drycleaners, two fashion design educators, two fabric specialists working with large retailers, and three consumers. The selected garments were not made apparent to shop personnel in order to minimize cleaning bias. Care labels were found on 355 of the 460 garments (77%). Of those

garments, 68% were labeled “dryclean,” “dryclean only,” or “professionally dryclean.” The remainder were labeled “hand or machine wash.” Exhibit 6-5 contains the results of these evaluations.

Exhibit 6-5. Results of Panel Evaluation of Wetcleaned Clothes at *The Greener Cleaner*

Evaluation Criteria	Percent of Total
Overall Appearance	
Excellent	28%
Good	39%
Fair	23%
Poor	10%
Presence of Odor	
None detectable	87%
Slight odor	7%
Fresh odor	3%
Objectionable odor	3%
Stain Removal	
No stain detectable prior to cleaning	53%
Stain/soil completely removed	21%
Minor stain/soil remain	7%
Stain/soil remain	19%
Dimensional Change - Woven Garments	
0 to 2% dimensional change	62%
2 to 4% dimensional change	27%
Greater than 4% dimensional change	11%
Dimensional Change - Knit Garments	
0 to 2% dimensional change	20%
2 to 4% dimensional change	22%
Greater than 4% dimensional change	58%

Evaluators commented on the general appearance of the garment before and after cleaning. Evaluators did not note any of the following problems for clothes evaluated: color unevenness, splotchiness, tears, missing buttons, or other problems related to cleaning and finishing.

Dimensional change measurements were noted in test garments in terms of the maximum amount per garment. In one example, a jacket shrinks 1% in length, 0% in the waist, and 2% in the sleeves. Its maximum dimensional change is therefore reported as -2%. The variables reported for this aspect of the evaluation included fiber type, fabric (knit or woven), garment type, color, and care label. The study indicated that dimensional change is best correlated with fabric type (i.e., knit garments). Operators modified their cleaning procedure by placing knit garments in mesh bags prior to washing, thus reducing the effect of mechanical action on dimensional change. After drying to 15% residual moisture, sweaters were placed on flat surfaces to complete the drying process.

Side-by-Side Evaluation of Identical Garments

In this test, 52 sets of identical garments (three per set) were compared throughout six wash-and-wear cycles. One garment per set was wetcleaned at *The Greener Cleaner*, one was drycleaned at one of six different shops, and the third was used as a control for comparison. Volunteers wore garments and

noted any unusual wearing conditions such as spills, tears, or rips. An effort was made to make these tests blind; for example, wearers did not know which cleaning method would be used. Evaluation of the garments took place immediately after purchase and again after multiple wash and wear cycles. Exhibit 6-6 summarizes the results of these evaluations, which include general appearance and color change. Although both cleaning methods were evaluated with similar success in terms of color change (87% and 85%, respectively), the general appearance of wetcleaned garments had significantly lower acceptance (63%) than the drycleaned ones (88%).

Exhibit 6-6. Side-by-Side Evaluations of Identical Wet and Drycleaned Garments

	Acceptable	Not Acceptable
General Appearance		
Drycleaned	88%	12%
Machine wetcleaned	63%	37%
Color Change		
Drycleaned	85%	15%
Machine wetcleaned	87%	13%

Exhibits 6-7a and 6-7b summarize the evaluations of maximum dimensional change for woven garments and fabrics. Exhibits 6-8a and 6-8b summarize the evaluations of maximum dimensional change for knit garments and fabrics. The wool, rayon, and silk fabrics seemed to exhibit the most dimensional change (greater than 6%) for both knit and woven garments. These results indicate that greater percentages of wetcleaned woven and knit garments (21% and 77%, respectively) exhibit significant dimensional change (greater than 4%) than similar drycleaned garments (5% and 38%, respectively).

Comparison of “Old” Clothing After Multiple Wet and Drycleanings

A small sample (25 garments) of volunteer-owned clothing was selected and assigned by coin toss to either the wet or drycleaning process. Clothing samples were evaluated, cleaned six times, and re-evaluated for evaluator and volunteer approval, as well as maximum dimensional change. Protocols similar to those used in the previous evaluations were followed to maintain accuracy and test validity. A greater number of the wetcleaned garments experienced more dimensional change than the drycleaned ones. Evaluators noted that 7 of 11 wetcleaned garments and 6 of 11 drycleaned garments were judged “good.” Researchers note that the small sample size and absence of control garments limits the value of this comparison.

Additional Comments

The CNT project was designed to mirror an average commercial drycleaning operation in terms of volume, rates, and fabric and garment types cleaned (Patton, 1996). Prior to the release of the UCLA wetcleaning study, the CNT study represented one of the most complete wetcleaning studies to date. Researchers concluded that wetcleaning, although not a complete replacement for drycleaning, is a viable substitute for a significant percentage of clothing labeled “dryclean only.” They also concluded that the many variables associated with performance assessment make it difficult to establish a generic guide appropriate for commercial cleaning shops (CNT, 1996).

Exhibit 6-7a. Maximum Dimensional Change for Woven Garments^a

Garment Type	0-2% Dim. Change		2-4% Dim. Change		4-6% Dim. Change		6+% Dim. Change		Total Number
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	
Pants	5	6	6	5					11
Jacket	3	5	2	1	2	1			7
Vest	2	2							2
Shirt				1			1		1
Blouse		1					1		1
Skirt	4	4	1	3	1	1	2		8
Scarf				1			1		1
Coat	1	1	4	4					5
Tie		1	3	2					3
Total % of Total	15 38%	20 51%	16 41%	17 44%	3 8%	2 5%	5 13%	0 0%	39

^a Thirty-nine sets of woven garments were analyzed in this comparison.

Exhibit 6-7b. Maximum Dimensional Change for Woven Fabrics^a

Fabric Type	0-2% Dim. Change		2-4% Dim. Change		4-6% Dim. Change		6+% Dim. Change		Total Number
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	
Cotton	1	1	2	2	1	1			4
Wool	5	8	7	7	2	1	2		16
Rayon	3	4	1	3			3		7
Silk	1	1	3	3					4
Linen	1	2	2	1					3
Acrylic	1	1							1
Polyester	3	3	1	1					4
Total % of Total	15 38%	20 51%	16 41%	17 44%	3 8%	2 5%	5 13%	0 0%	39

^a Thirty-nine sets of woven garment fabrics were analyzed in this comparison.

Exhibit 6-8a. Maximum Dimensional Change for Knit Garments^a

Garment Type	0-2% Dim. Change		2-4% Dim. Change		4-6% Dim. Change		6+% Dim. Change		Total Number
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	
Pants				1			1		1
Shirt							1	1	1
Sweater		2	3	5	2	3	6	1	11
Total % of Total	0 0%	2 15%	3 23%	6 46%	2 15%	3 23%	8 62%	2 15%	13

^a Thirteen sets of knit garments were analyzed in this comparison.

Exhibit 6-8b. Maximum Dimensional Change for Knit Fabrics^a

Fabric Type	0-2% Dim. Change		2-4% Dim. Change		4-6% Dim. Change		6+% Dim. Change		Total Number
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	
Cotton					1	1			1
Wool			1	3		1	3		4
Rayon						1	1		1
Silk			1	3			4	2	5
Linen		1			1				1
Acrylic		1	1						1
Total % of Total	0 0%	2 15%	3 23%	6 46%	2 15%	3 23%	8 62%	2 15%	13

^a Thirteen sets of knit garment fabrics were analyzed in this comparison.

6.2.3 Final Report for the Green Clean Project (October 1995)

Sponsors:	Environment Canada, Korean Dry Cleaners Association, Ontario Fabricare Association, Ontario Ministry of Environment and Energy
Investigating Organization:	Environment Canada
Duration of Study:	Phase I - June to November 1994; Phase II - December 1994 to February 1995; Phase III - September 1995 to March 1996
Location:	Phase I - Toronto and Markham, ONT; Phase II - Toronto, Markham, and Windsor, ONT; Phase III - Hamilton, ONT
Source of Information:	Environment Canada, 1995

Summary of Performance Evaluations

- Customer response surveys (Survey I - wet and steam options; Survey II - wet, steam, and dry options; Survey III - dry option) to rate garment appearance, fit, damage, cleaning, and repeat visit potential
- Analysis of customer claims based on first 6 months of Phase I
- Fabric swatch studies (related to shrinkage, color change, soil removal, and effect on fusible interfacing) performed for Environment Canada at the University of Guelph, Textile Science Group
- Comparison of 13 dry and wetcleaned consumer garments in terms of shrinkage, pressing quality and visual appearance, and pressing and finishing time

Project Description

Exhibit 6-9 provides a demonstration shop profile for the wetcleaning operation undertaken for this study. Exhibit 6-10 is a profile of the garment and fabric types wetcleaned during the same period.

Phase I of this study consisted of establishing a “drop-off” site (*Green Clean Depot*) for researching and evaluating customer acceptance of solvent-free cleaning (wetcleaning and steam cleaning with no drycleaning option). Multi-process wetcleaning technology was installed at two existing drycleaning plants.

Exhibit 6-9. Wetcleaning Shop Profile for the Green Clean Project^a

<i>Description</i>	Multiple garment cleaning plants; wet and drycleaning equipment on premises
<i>Location</i>	Toronto, Ontario, Canada
<i>Shop Size</i>	Varies
<i>Wet Cleaning Equipment^e</i>	IPSO/Aqua Tex: HFH 145 (18 lb), 324 (50 lb), 304 (70 lb) Milnor 30022F8W (33 pounds) Aqua Clean: 30S (18 pounds), 50S (30 pounds), 80S (80 pounds) Unimac: UA 75, 160 (12 pounds), 230 (20 pounds), 400 (52 pounds) Miele WS 5190 TR
<i>Drying Equipment</i>	Aqua Tex - American W/C (30 pounds) American: ADS 50 (30 pounds) and 75 (45 pounds) Aqua Clean S & G 30 (18 pounds), 50 (30 pounds), 80 (48 pounds) Unimac DTB - 50/75 CSHPMM (18 pounds, 30 pounds, 45 pounds) Miele T6550 TR
<i>Finishing Equipment</i>	Not specified
<i>Cleaning Supplies</i>	Not specified
<i>Sample Price List</i>	Not specified

^a All machine capacities (pounds) represent 60% of laundry capacity specified by manufacturer.

In Phase II a private operator took over the *Green Clean Depot*. Three additional wetcleaning locations were established. Customers were given the option of multi-process wet or drycleaning.

In Phase III an existing drycleaning plant was converted to a wetcleaning-only facility. During this phase project participants evaluated the financial viability of a wetclean-only plant, as compared to a drycleaning alternative.

The results presented in the October 1995 report study were collected between June 1994 and February 1995. They apply to all of Phase I and the first 3 months of Phase II.

Customer Satisfaction Survey

Up to three survey cards per customer were distributed with each garment cleaned. Postage was pre-paid on cards for return mail, and cards were also accepted at the drop-off points. A breakdown of the survey response is as follows: 412 responses for Survey I on wet and steam options (June 6 to November 30, 1994); 60 responses for Survey II on wet, steam, and dry options (December 1994 to February 1996); and 201 responses for Survey III on drycleaning only (November 1994 to April 1995). Note that the survey schedule does not necessarily correlate with the project schedule. Also, the Survey II results are not differentiated in terms of cleaning method.

Exhibit 6-10. Garment Profile Summary for the Green Clean Depot

Garment Type	Number Cleaned June–November 1994	Number Cleaned December 1994– February 1995
Bedding	72	29
Coat	231	102
Drapes	18	2
Dress	217	68
Pants	916	446
Shirt (hand pressed)	547	248
Skirt	443	140
Shorts	53	3
Suit jacket	757	258
Suit vest	71	27
Sweater	258	172
Ties	20	11
T-shirt	26	5
Machine pressed shirts	1,391	385
Other	162	52
Fabric Type		
Cotton, polyester, nylon	905	333
Wool	815	450
Wool polyester mix	308	8
Angora/cashmere	37	48
Linen	195	89
Rayon	439	176
Silk	315	141
Rayon linen/acetate viscose mix	321	90
Rayon, cotton, linen mix	152	11
Rayon, linen, ramie mix	112	15
Down	29	14
Leather and suede	29	0
Unknown	134	188
Total	5,182	1,948

Exhibit 6-11 is a summary of the results obtained from customer satisfaction surveys. Exhibit 6-12 summarizes the negative responses received for each survey. The results of the second survey do not distinguish which of the three cleaning methods was chosen by customers. In addition, the response rates for Surveys II (9.7%) and III (3.5%) were much lower than the response rate for Survey I (27.4%). The Green Clean report makes the following overall observations regarding these customer response surveys:

- There was little difference in the amount of garment shrinkage reported on the surveys.
- Garment damage was not significant, with the exception of button deterioration associated with drycleaning.
- In evaluating general appearance, 97% of customers who chose wetcleaning (Survey I), 97% of customers who chose wet/steam/drycleaning (Survey II), and 98% of customers who chose drycleaning (Survey III) stated that their clothing was clean overall.

Exhibit 6-11. Summary of Customer Satisfaction Surveys^a

Survey Question	Response	SI - Wet/Steam Clean Options ^a	SII - Wet, Steam, and Dry Options ^b	SIII - Dry Option Only ^c
Garment Appearance - Are clothes pressed/finished nicely?	Yes No	93% 7%	90% 10%	97% 3%
- Is the shaping/body OK?	Yes No	96% 4%	95% 5%	98% 2%
- Do any seams pucker or bulge?	Yes No	4% 96%	1% 99%	2% 98%
- How is the color?	No change Some improvement Not an improvement	89% 9% 3%	83% 11% 6%	91% 6% 3%
Garment Fit - How is the size?	No change Some shrinkage Some stretching	95% 5% <1%	98% 0% 2%	95% 5% 0%
Garment Damage - Are there any new tears?	Yes No	0% 100%	0% 100%	0% 100%
- Are buttons and decorations OK?	Yes Not applicable Broken or missing	89% 11% <1%	87% 12% 1%	77% 17% 6%
Garment Cleaning - Is the clothing clean overall?	Yes No	97% 3%	97% 3%	98% 2%
- Were stains or spots removed?	Not applicable Yes No	44% 50% 6%	42% 51% 7%	39% 55% 5%
- Is any unpleasant odor present?	Yes No	1% 99%	2% 98%	5% 95%
Customer Return - Will use Cleaner again	Yes No	95% 5%	97% 3%	98% 2
Number of Surveys Returned Survey Response Rate		412 27.4%	60 9.7%	201 3.5%

^a Wet and steam cleaning performed at two facilities for Survey I.^b Wet, steam, and drycleaning performed at one facility for Survey II.^c Drycleaning performed at six facilities for Survey III.

Exhibit 6-12. Summary of Customer Satisfaction Surveys with Negative Responses

Survey Question	Survey I ^a			Survey II ^b	Survey III ^c
	Number of Responses	Wetclean	Steam Clean	Number of Responses	Number of Responses
Garment Appearance - <i>Not pressed and finished nicely</i> - <i>Shaping or body not OK</i> - <i>Seams pucker or bulge</i> - <i>Change in color of garment, no improvement</i>	29 17 16 13	19 12 11 10	10 5 5 3	5 3 0 4	7 4 4 5
Garment Fit - <i>Some shrinkage/stretching</i>	24	14	10	1	10
Garment Damage - <i>Tears</i> - <i>Buttons and decorations not OK</i>	0 3	0 3	0 0	0 1	0 12
Garment Cleaning - <i>Garment is not clean overall</i> - <i>Odor</i> - <i>Stains and spots not removed</i>	13 5 25	10 5 18	3 0 7	2 1 5	5 10 11
Customer Return - <i>Will not use Cleaner again</i>	20	16	4	2	3
Number of Surveys Returned Survey Response Rate	412 27.4%			60 9.7%	201 3.5%

^a Wet and steam cleaning performed at two facilities for Survey I.

^b Wet, steam, and drycleaning performed at one facility for Survey II.

^c Drycleaning performed at six facilities for Survey III.

- Responses regarding stain and spot removal did not vary significantly among the three surveys.
- Customers were most dissatisfied with the color change associated with the wetcleaning-only option.
- Wetclean and dryclean-only customers responded similarly to questions about garment size.

Analysis of Customer Claims

Customer claims about damaged clothing were analyzed using the IFI's Fair Claims Guide. Claims were paid on 14 out of 3,791 garments cleaned during the first 6 months of operation (Survey I) of the *Green Clean Depot* (7 - color/dye run; 5 - shrinkage; 2 - stains and cracking). Out of 1,563 garments washed, 2 claims resulting from wetcleaning silk and specialty wool were paid between December 1994 and February 1995 (Survey II). No claims are mentioned in this study for the Survey III period.

Fabric Swatch Studies

Some data regarding fabric swatch studies performed at the University of Guelph (Section 6.2.7) are presented in this study. Swatches were tested using drycleaning (Lindus Dry-to-Dry Refrigerated System), wetcleaning (Wascomat Aqua Clean Washer and Dryer System; IPSO Washer and American Dryer System), home laundering (Maytag Top-loader Laundry Machine), steam cleaning (steam gun and detergent spray treatment), and pressing only.

The following types of fabric swatches were tested in this experiment: undyed test fabrics (for shrinkage), dyed consumer fabrics (for shrinkage and color change), standard soiled fabrics (for soil removal), and bonded fabrics (for determining effects on fusible interfacing). All fabrics, except bonded fabrics, were prepared and measured by students and faculty in the Textile Science Group at the University of Guelph. Bonded fabrics were prepared and evaluated by Canada Hair Cloth, a Canadian manufacturer. A total of 414 swatches were processed 950 times at two drycleaning facilities in Toronto with regular garment loads. Pressing was completed according to ASTM D-2724-87 (Bonded Apparel Fabrics Method) by Environment Canada staff.

Exhibit 6-13 contains the results for the shrinkage studies on processed undyed fabric swatches. The study identifies both rayon and wool as fabrics with “problem shrinkage.” Past experience with drycleaning, however, indicates that shrinkage may have been exaggerated for the undyed test fabrics in this study (Environment Canada, 1995).

Exhibit 6-13. Percent Warp Shrinkage of Undyed Fabrics After One Cleaning^a

Fabric Swatch	Press Only	Dryclean	Steam Clean	Home Laundry	Wetclean (GC)	Wetclean (WC)
Low Shrinkage (Less than 3%)						
Polyester plain	0.00	0.80	0.67	1.73	1.47	0.80
Cotton/polyester	0.00	0.00	0.47	0.40	0.53	0.40
Silk	0.27	0.00	-0.13	4.67	-0.53	0.40
Moderate Shrinkage (Less than 5%)						
Acetate	1.33	1.87	3.13	3.07	2.80	3.60
Mercerized cotton	0.00	0.40	3.73	5.20	4.27	4.40
Cotton	0.80	3.47	6.73	10.00	7.60	8.40
Worsted wool	2.13	3.07	5.07	10.40	6.40	6.13
Linen	0.53	0.80	2.93	8.13	5.13	4.80
Problem Shrinkage (more than 5%)						
Wool	2.00	2.53	4.40	12.27	7.53	7.33
Rayon	0.93	0.27	4.40	7.87	6.07	7.33

^a Percent shrinkage is calculated on the basis of original measurements on fabrics.

Exhibit 6-14 contains the results of a shrinkage study performed on dyed consumer fabrics that were donated by garment manufacturers. Problem shrinkage was exhibited in the following fabrics: polyester after one drycleaning, light wools and polyester after five wetcleanings, and laundered light wools and polyesters after one or more cleanings. Steam cleaning produced no problems except for slight bubbling of polyester after the fifth cleaning. There was a wide range of results for bonded fabric interfacing, indicating the difficulty in predicting results for some cleaning methods, especially wetcleaning.

Exhibit 6-15 contains the results of standard soil removal tests for cotton fabric swatches. In addition, a white swatch area was evaluated for soil redeposition. Results for drycleaning indicate that it was deficient in cleaning blood and red wine and had the highest amount of redeposition. Wetcleaning was most effective with blood and red wine and had the lowest amount of redeposition. Home laundry removed the highest amount of carbon black/mineral oil. Steam cleaning seemed to have little or no soil removal capacity.

Exhibit 6-14. Percent Shrinkage Results for Consumer Fabric Swatches^a

Fabric Swatch	Press Only	Dryclean	Steam Clean	Wetclean (Wascomat)	Wetclean (IPSO)	Home Laundry
Low Shrinkage (Less than 3%)						
100% Polyester plain	0.0%	0.4%	1.1%	1.2%	0.5 %	3.1%
55% Cotton/45% polyester plain	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
100% Polyester twill	1.2%	2.1%	1.5%	2.0%	0.9%	4.9%
100% Mercerized cotton ripstop	0.1%	0.3%	1.6%	2.0%	1.7%	2.7%
100% Silk	0.7%	0.0%	0.0%	- 0.3%	- 0.9%	1.5%
50% Linen/50% polyester	0.4%	0.5%	1.3%	1.2%	1.3%	2.1%
Moderate Shrinkage (Less than 5%)						
70% Wool/20% nylon/10% cashmere	1.6%	1.6%	4.3%	4.7%	4.3%	8.4%
Problem Shrinkage (more than 5%)						
96% Cotton/4% lycra twill	0.8%	4.1%	3.2%	5.7%	5.2%	10.1%
64% Acetate/36% rayon crepe	1.7%	1.6%	4.8%	8.7%	7.3%	9.5%
95% Rayon/5% silk	0.1%	2.0%	5.1%	9.3%	5.9%	14.4%
100% Wool (loose weave)	0.0%	1.1%	2.4%	5.5%	5.3%	8.3%

^a Results are presented for maximum shrinkage in either warp or weft direction after one cleaning. Results in most cases are for 40 cm (15 inch) square fabric swatches with triplicate measurements. Results were within the 99% confidence interval for 98.5% of measurements. Results were within the 95% confidence interval for 100% of measurements.

Exhibit 6-15. Percent Soil Removal from Standard Soil Test Fabrics

Soil Type	Dryclean	Steam Clean	Home Laundry	Wetclean (IPSO & Lever)	Wetclean (Aqua Clean)
Unsoiled (redeposition)	6	2	3	3	1
Carbon black/mineral oil	30	10	68	24	30
Cocoa	18	0	16	7	7
Blood	8	0	39	58	20
Red wine	4	2	14	10	20

Garment Comparison Study

Thirteen sets (three identical garments per set, including one control) of consumer garments were compared after multiple wet and drycleanings. Garment samples were selected to represent clothing typically drycleaned. They were wet and drycleaned five times with other laundry loads, alternating between the two facilities. Pressing facilities included a medium/large facility (Cleaner A) and a relatively small facility (Cleaner B) in order to assess differences in pressing times.

Results for shrinkage, pressing quality, visual appearance, and pressing and finishing time are presented in Exhibits 6-16, 6-17, and 6-18. In general, results for shrinkage and finishing quality varied, depending on textile type. Finishing problems are noted for the rayon blouse (wet), cotton knit shorts (wet and dry), viscose/linen jacket (wet and dry), wool/viscose dress (wet), and wool/polyester/pinstripe dress (wet and dry).

Pressing and finishing time was reported to be a function of shrinkage; that is, garments with significant shrinkage require more time to return to their pre-cleaning state. Wetcleaned garments required between 5% and 50% more pressing time, compared to drycleaned garments. Exhibit 6-18 presents a range, as a result of differences identified in facility scale, and percent capacity used, of dry and wetcleaning options. It was concluded that some garments should not be wetcleaned based on the amount of pressing time required to adequately restore them.

Exhibit 6-16. Percent Garment Shrinkage Results Before and After Pressing^a

Color	Material	Garment	Point of Measure	Cleaner A ^b		Cleaner B ^c	
				Dryclean	Wetclean	Dryclean	Wetclean
Garments with Shrinkage Less than 3%							
Red	100% Silk	Shirt (Protocol)	After drying After pressing	0.7% 0.0%	1.3% 1.1%	1.7% 0.5%	1.2% 1.0%
Patterned Multi-color	100% Silk	Tie (Leo Chevalier)	After drying After pressing	0.5% - 0.6%	0.5% - 0.3%	2.2% 0.8%	1.6% 0.1%
Beige	100% Linen	Shirt (Dalia)	After drying After pressing	0.3% 0.0%	1.6% 1.2%	1.2% 0.8%	1.7% 1.1%
Brown	100% Cotton	Pants (Functionals)	After drying After pressing	1.3% 0.5%	1.4% 0.8%	1.8% 0.9%	1.4% 0.8%
Grey	100% Wool	Pants (Protocol)	After drying After pressing	0.5% 0.0%	1.6% 0.8%	1.2% 0.1%	1.8% 1.2%
Patterned Black/White	100% Wool	Pants (Cool Wool)	After drying After pressing	1.3% 0.0%	1.8% 0.7%	0.3% 0.0%	2.2% 0.6%
Patterned Black/White	100% Wool	Suit Jacket (Cool Wool)	After drying After pressing	0.4% 0.1%	0.5% 0.8%	1.3% 0.5%	1.3% 0.4%
Light Green	100% Polyester	Suit Jacket (Tan Jay)	After drying After pressing	0.3% 0.3%	0.9% 0.9%	0.7% 0.4%	1.3% 1.1%
Garments with Shrinkage Greater than 3%							
Patterned Multi-color	100% rayon	Blouse w/pads (Jessie)	After drying After pressing	0.9 0.4	5.4 4.4	2.1 0.5	6.5 3.0
White	100% cotton knit	Shorts (Divine One)	After drying After pressing	1.2 0.8	15.2 15.6	4.6 4.2	16.0 14.5
Light Blue	80% Viscose 20% Linen	Suit Jacket (Sterling)	After drying After pressing	1.4 0.8	5.7 3.7	2.2 1.0	7.6 2.7
Dark Blue	60% Wool 40% Viscose	Dress (Holt Renfrew)	After drying After pressing	1.2 0.9	4.5 1.7	2.0 0.6	4.8 1.5
Brown Pinstripe	99% Wool 1% Polyester	Dress (Holt Renfrew)	After drying After pressing	0.5 0.2	9.9 8.0	1.7 0.5	10.0 4.6

^a Shrinkage results are calculated from original reference measurements and are cumulative effects. Results are for the same garments after four and five cleanings, respectively, for Cleaner A and Cleaner B.

^b Cleaner A cleaned and pressed garments for the second and fourth treatments.

^c Cleaner B cleaned and pressed garments for the first, third, and fifth treatments.

Exhibit 6-17. Garment Pressing Quality

Color	Material	Garment	Cleaner A ^{a,b}		Cleaner B ^{a,c}	
			Dryclean	Wetclean	Dryclean	Wetclean
Garments with Low Shrinkage (Less than 3%)						
Red	100% Silk	Shirt (Protocol)	B	B	A	A
Patterned multi-color	100% Silk	Tie (Leo Chevalier)	A	A	A	A
Beige	100% Linen	Shirt (Dalia)	B	B	A	A
Brown	100% Cotton	Pants (Functionals)	A	A	A	A
Grey	100% Wool	Pants (Protocol)	A	A	A	A
Patterned black/white	100% Wool	Pants (Cool Wool)	A	A	A	A
Patterned black/white	100% Wool	Suit jacket (Cool Wool)	A	A	A	A
Light green	100% Polyester	Suit jacket (Tan Jay)	A	A	A	A
Garments with Problem Shrinkage (More than 3%)						
Patterned multi-color	100% Rayon	Blouse w/pads (Jessie)	A	A	A	A
White	100% Cotton knit	Shorts (Divine One)	B	A	B	A
Light blue	80% Viscose 20% Linen	Suit jacket (Sterling)	B	D	B	C
Dark blue	60% Wool 40% Viscose	Dress (Holt Renfrew)	B	B	B	B
Brown pinstripe	99% Wool 1% Polyester	Dress (Holt Renfrew)	B	D	B	C

^a A - Finished Nicely; B - Some Minor Defects; C - Many Minor Defects; D - Major Defects/Possible Claim/Unwearable.

^b Cleaner A cleaned and pressed garments for the second and fourth treatments.

^c Cleaner B cleaned and pressed garments for the first, third, and fifth treatments.

Exhibit 6-18. Garment Pressing Time

Color	Material	Garment	Cleaner A ^a			Cleaner B ^b		
			Dryclean (min.)	Wetclean (min.)	% More W/C time ^c	Dryclean (min.)	Wetclean (min.)	% More W/C time ^c
Garments with Low Shrinkage (less than 3%)								
Red	100% Silk	Shirt (Protocol)	2.4	2.5	3%	2.9	3.3	11%
Patterned multi-color	100% Silk	Tie (Leo Chevalier)	0.5	0.5	0%	0.3	0.3	0%
Beige	100% Linen	Shirt (Dalia)	2.9	2.8	- 3%	4.0	4.3	8%
Brown	100% Cotton	Pants (Functionals)	1.9	1.9	0%	1.8	1.8	0%
Grey	100% Wool	Pants (Protocol)	2.4	2.6	7%	1.9	2.3	17%
Patterned black/white	100% Wool	Pants (Cool Wool)	1.8	2.0	9%	2.3	2.7	15%
Patterned black/white	100% Wool	Suit Jacket (Cool Wool)	2.5	2.6	3%	3.3	3.8	15%
Light green	100% Polyester	Suit Jacket (Tan Jay)	1.8	1.5	- 18%	2.5	2.3	- 10%
Garments with Problem Shrinkage (more than 3%)								
Patterned multi-color	100% Rayon	Blouse w/pads (Jessie)	0.9	0.9	0%	1.5	1.7	11%
White	100% Cotton knit	Shorts (Divine One)	1.0	0.9	- 8%	1.2	1.0	- 15%
Light blue	80% Viscose 20% Linen	Suit Jacket (Sterling)	3.1	3.9	27%	3.5	6.7	91%
Dark blue	60% Wool 40% Viscose	Dress (Holt Renfrew)	1.2	2.3	99%	2.7	3.8	43%
Brown pinstripe	99% Wool 1% Polyester	Dress (Holt Renfrew)	3.5	6.3	81%	3.3	7.8	135%

^a Cleaner A cleaned and pressed garments for the second and fourth treatments.^b Cleaner B cleaned and pressed garments for the first, third, and fifth treatments.^c W/C denotes wetcleaning.

6.2.4 Pollution Prevention in the Garment Care Industry: Assessing the Viability of Professional Wetcleaning, Final Report (*Cleaner by Nature*) (December 11, 1997)

Sponsors:	South Coast Air Quality Management District, California Air Resources Board, USEPA Office of Research and Development, UCLA Center for Environmental Risk Reduction, University of California Toxic Substances Research and Training Program, Occupational and Environmental Division of the Los Angeles County District Attorney's Office
Investigating Organization:	UCLA /Occidental College, Pollution Prevention Education and Research Center
Principal Investigator:	Robert Gottlieb
Duration of Study:	1 year (February 1996 to January 1997)
Location:	Los Angeles, California
Source of Information:	Gottlieb et al., 1997

Summary of Performance Evaluations

- Profile of customer garments cleaned at *Cleaner by Nature*, including information about the care labels of garments, the garment type, and the fiber type
- Analysis of rejected garments, redos, and customer claims to provide a quantitative measurement of the extent and type of garments that pose a problem for professional wetcleaning
- Repeat clean test to compare professional wetcleaning and drycleaning performance after the repeated wearing and cleaning of "dryclean only" labeled garments
- Survey of volunteers wearing the garments used in the repeat clean test, used to compare the results from the quantitative measurement of test garments in the repeat clean test with the experience of customers wearing these same garments
- Telephone survey of *Cleaner by Nature* and drycleaning customers, used to measure their experience and level of satisfaction with the professional wetcleaning process compared to the drycleaning process

Cleaner by Nature Wetcleaning Demonstration Site

The *Cleaner by Nature* demonstration site opened on February 6, 1996, as a wetcleaning-only facility, located in Los Angeles, California. A drop-off store was located in Santa Monica. The combined operation was set up as a small drycleaning shop, with the exception of the cleaning equipment. Exhibit 6-19 contains a demonstration profile for this wetcleaning operation.

A total of 34,950 garments were processed by *Cleaner by Nature* during the first year of operation (February 1, 1996, and January 31, 1997). However, a computer register failure during the months of October, November, and December 1996 corrupted some of the data set for this study. Additional data were lost for the month of August 1996; however, data are included from March 11 to April 11, 1997. Therefore, in some instances data analyzed in the final report are from variable time periods, as specified in the following summaries.

Exhibit 6-19. Demonstration Shop Profile for *Cleaner by Nature*

<i>Description</i>	100% wetcleaning operation with a Santa Monica agency and a Los Angeles plant	
<i>Location</i>	2407 Wilshire Blvd., Santa Monica, CA 904023 (agency) 3317 La Cienega Place, Los Angeles, CA 90016 (plant)	
<i>Size</i>	~ 850 sq. ft. (agency) ~ 2,000 sq. ft. (plant)	
<i>Personnel</i>	1 full-time clerk, 1 to 2 part-time clerks, 1 part-time delivery person (agency) 1 full-time cleaner, 1 part-time presser, 1 part-time assembly person (plant)	
<i>Cleaning/Drying Equipment</i>	Aquatex 30/50 lb. microprocessor washer Aquatex 50 lb. microprocessor dryer Maytag domestic washer Maytag domestic dryer	
<i>Pressing/Finishing Equipment</i>	Forenta hot head press Forenta utility press Cissell steam iron (2) Forenta upright pant topper (reconditioned) Cissell form finisher (reconditioned) Forenta 3-way puff (reconditioned) High-steam JAM 500 tensioning form fitter (reconditioned) ^a High-steam PAM 200 tensioning pant topper (reconditioned) ^a	
<i>Other Equipment</i>	Spotting Board Lattner 9.5 HP gas boiler Rol-Aire 5 HP vertical compressor Vertical dryset vacuum 800 slot conveyor (Iowa Tech) Rayne water conditioning unit	
<i>Cleaning Supplies</i>	Aquatex detergent Aquatex finish Aquatex leather detergent Aquatex leather finish	
<i>Cycle Length</i>	Wash cycle 18 to 20 minutes Dry cycle 15 to 30 minutes	
<i>Sample Price List</i>	Pants/skirt	\$ 4.15
	2-Piece suit	8.75
	Dress	7.75
	Shirt/blouse	4.35

^a Purchased in September 1996; tensioning equipment has replaced the function of the Forenta pant topper and Cissell form finisher originally purchased by *Cleaner by Nature*.

Profile of Customer Garments

Exhibit 6-20 shows a profile of the garment types cleaned by *Cleaner by Nature* from February to September 1996 and for January 1997. During this time period a total of 23,094 identifiable garments and 559 unidentifiable garments were wetcleaned at the facility. The study notes that jackets may be under-represented because of the missing data for the colder months of October, November, and December. However, garment profile data collected by a drycleaner during January 1997 are comparable to the data collected by *Cleaner by Nature* for the duration of the study.

**Exhibit 6-20. Garment Types Cleaned at *Cleaner by Nature*
(February 1 to September 30, 1996, January 1997)**

Garment Type	Total	Percentage
Pants	5,675	24.0
Shirts/blouses	5,456	23.1
Suit jackets/outer jackets	2,267	9.6
Sweaters	2,142	9.1
Dresses	1,726	7.3
Skirts	1,311	5.5
2-piece suit, 2-piece tuxedo ^a	794	3.4
Bedding ^b	442	1.9
Household items ^c	686	2.9
Vests	334	1.4
Shorts	427	1.8
Ties	198	0.8
Miscellaneous ^d	1,077	4.6
Unknown	559	2.4
Total	23,653	100.0 %

^a Two- and three-piece suits are counted as one item.

^b Includes sheet, pillow case, sham, and comforter.

^c Includes tablecloth, curtain, napkin, drape, and sofa cover.

^d Includes coat, raincoat, hat, gloves, robe, three-piece suit, jumpsuit, nightwear, shawl, culottes, shoes, and sleeping bag.

Exhibit 6-21 provides a profile of fiber types for the garments cleaned during the demonstration period. This data set includes 60% (20,808/34,950) of those garments cleaned for which fibers could be properly identified. The percentage of wool garments cleaned during the demonstration period may be under-represented because of the corrupted data for October, November, and December. Wool, linen, mohair, silk, cashmere, rayon, and acetate fibers, which are all typically drycleaned, account for 70% of all garments cleaned by *Cleaner by Nature*. Cotton was the fiber cleaned most frequently by *Cleaner by Nature* (24%).

Exhibit 6-21. Fiber Types Cleaned at *Cleaner by Nature* (February 1, 1996 to January 1997)^a

Fiber	Wool	Down ^b	Misc. ^c	Linen	Silk	Cashmere	Rayon	Acetate	Polyester ^b	Cotton ^b
% of Total	18.8%	0.6%	1.1%	10.9%	15.5%	0.9%	21.9%	2.3%	4.3%	23.8%

^a This profile of fiber types represents 60% of the garments cleaned by *Cleaner by Nature*, for which fiber information was available (20,808/34,950).

^b Cotton, polyester, and down are not fibers normally labeled "dryclean only."

^c Miscellaneous (Misc.) includes acrylic, leather, and ramie.

Profile of Problem Garments

During the demonstration period, *Cleaner by Nature* kept records on four types of problem garments:

- *Rejects* - garments turned away by the cleaner because they could not be safely cleaned;
- *Customer claims* - damaged or lost garments that needed to be replaced;
- *Store credits* - store credit awarded for damaged or lost garments; and
- *Redos* - garments brought back by customers who felt their clothing required additional attention.

The number of rejects was tracked at *Cleaner by Nature* from February 1996 to August 1996 and from September 1996 through January 1997. A total of 33 items (0.09% of total) were rejected by *Cleaner by Nature*, the majority because of potential problems with colorfastness (90%). There was no comparative information on rejects available for drycleaning.

The number of claims (cash payments for lost or damaged garments) paid to *Cleaner by Nature* customers was tracked from February 1996 to August 1996, September 1996 to January 1997, and March 11, 1997, to April 11, 1997. There were a total of 14 customer claims on the 44,860 garments cleaned during these periods. Over half of the claims (eight) were related to shrinkage problems. The study notes that there was a decline in the claim rate as a result of the increased experience of the cleaner at the facility.

In addition to cash payments made for claims on lost or damaged garments, *Cleaner by Nature* issued store credit when problems occurred with garments. Data for store credit issued were collected from November 1996 through April 11, 1997. During this 5-month period, the store manager reported issuing store credit for 8 garments out of 21,937 cleaned (0.037%). Researchers combined the claims rate for the post-start-up period (0.010%) and the store credit rate for this 5-month period (0.037%) for a total rate of 0.047% (11 out of 21,937 garments).

The study also compared the claims and store credit rate for *Cleaner by Nature* with those of a local drycleaning facility. Researchers note that the drycleaner had a policy of awarding store credit as rarely as possible, which is the reason for combining the store credit and claims data in this comparison. Even though lost garments are not necessarily a direct measure of cleaning performance, they are included in the analysis because the owner of the drycleaner suspected that spotters who ruin garments may be tempted to "lose" garments in order to avoid responsibility for the damage. *Cleaner by Nature's* combined claims/store credit rate (0.047%, or 11 of 21,937 garments cleaned) was about three times greater than the figure for the drycleaner (0.015%, or 16 of 107,692 items cleaned).

The total redo rate for *Cleaner by Nature* was 0.52% (163 redos out of 31,524 garments cleaned) for data collected between February 1996 and January 1997, but excluding August 1996. This redo rate is comparable to that of a local drycleaner, whose overall redo rate was 0.45% (59 redos out of 13,256 garments cleaned). Spotting (i.e., stain removal) was reported as the most common reason for a redo (40%), followed by pressing (25%), shrinkage (25%), colorfastness problems (4%), odor (3%), and other miscellaneous damage (3%). The study reports that the redo rate was related to the level of expertise of the facility's cleaners, noting that the redo rate increased in months when a new cleaner was hired. The following related observations were reported, including:

- There was a general decline in the percentage of garments returned for problems related to spotting and shrinkage during the study period.
- Pressing problems did not appear to decline over the study period, which is potentially related to the high turnover rate for pressers.
- Customers returned silk garments for additional work at a higher than expected rate (25% of all redos were silk).
- Thirty-nine percent of all spotting problems were related to silk garments.
- Thirty-six percent of all pressing problems were related to wool garments, and 18% were related to linen garments.
- Fifty-four percent of garments redone for shrinkage were rayon.

Repeat Clean Test

A blind repeat clean test was used to compare the performance of wet and drycleaning on garments labeled "dryclean only" after repeated cleaning and wear. Three identical sets of 40 "dryclean only" garments were obtained for the test. One of the sets was wetcleaned six times, another drycleaned six times, and a third stored for comparison. Volunteers were recruited to wear two garments from the wet and drycleaned sets between cleanings. Trained evaluators were used to determine changes in garment dimensions, general appearance, color, color migration, and odor.⁴ Evaluators and wearers were not informed as to which garments were being dry or wetcleaned. Garment types included shirts/blouses, pants, skirts, dresses, jackets, sweaters, vests, and ties. Fiber types included acetate, acrylic, cashmere, linen, polyester, rayon, silk, and wool. In addition, a representative sample of woven versus knit; tailored versus unstructured; and light, medium, and dark colors was chosen.

Exhibit 6-22 shows the results of the dimensional change experiments for measurements of length and width, as compared to drycleaned garments. For each garment, dimensional change was calculated as the difference between the initial measurement and the final measurement, divided by the initial measurement. AATCC test method 158-1990 was used for guidance on dimensional change calculations. The average dimensional change in length was 2.65% for wetcleaning and 2.35% for drycleaning. The average dimensional changes in width for wetcleaning (2.96%) and drycleaning (2.97%) were virtually identical. Therefore, the study notes that there were no statistically significant differences in measurements between dry and wetcleaning. The study also states that while dimensional change varied substantially depending on a garment's construction, fiber, and fabric, the cleaning method did not alter the results significantly.

⁴Although not reported in this study, the evaluators also tested for garment resiliency, stain and soil removal, and hand. Researchers noted that both cleaning methods performed similarly for these tests.

**Exhibit 6-22. Dimensional Change for Identical “Dry Clean Only” Garments
Repeatedly Wet Cleaned and Dry Cleaned^a**

Grouping	Length - Dimensional Change			Width - Dimensional Change		
	(n) ^b	Wetclean	Dryclean	(n) ^b	Wetclean	Dryclean
All Garments	36	2.65%	2.35%	35	2.96%	2.97%
Fabrication						
Woven	29	2.20%	2.05%	28	2.18%	2.14%
Knit	7	4.48%	3.58%	7	6.08%	6.31%
Construction						
Tailored	22	2.37%	1.75%	21	2.24%	1.87%
Unstructured	14	3.07%	3.30%	14	4.03%	4.71%
Fiber						
<i>100% & blends</i>						
Rayon	12	3.26%	3.28%	12	3.09%	3.52%
Silk	10	2.31%	1.92%	8	2.18%	1.84%
Wool	7	2.60%	2.38%	7	3.59%	4.14%
Linen	5	2.64%	1.30%	6	2.51%	2.57%
<i>Origin</i>						
Natural ^c	21	2.51%	1.95%	19	2.98%	3.03%
Manf. ^d	11	2.60%	3.29%	11	3.90%	3.96%

^a Percentage measurements noted are averages.

^b (n) refers to the number of pairs of garments, with one wetcleaned and one drycleaned.

^c Natural fibers include wool, silk, linen, or blends of natural fibers (including cotton).

^d Manufactured fibers include rayon, polyester, acetate, or blends of manufactured fibers (including acrylic).

Exhibit 6-23 contains the results of the expert panel’s general appearance evaluations, including cleaning performance quality, and the acceptability of appearance and pressing. The exhibit identifies cases where a problem was identified with one garment in the pair but not with the other (discordant pairs) and cases where the evaluator was either satisfied or dissatisfied with both garments (concordant pairs). The study notes that most garment pairs were judged acceptable in terms of pressing (35 of 39) and general appearance (32 of 40).

Exhibit 6-23. Performance Quality and Acceptability of General Appearance Evaluations

Performance Quality and Acceptability Ratings ^a	Discordant Pairs		Concordant Pairs	
	Yes - WC ^b No - DC ^c	No - WC Yes - DC	Yes - WC Yes - DC	No - WC No - DC
Color consistency problems	5	2	2	30
Tears, rips, split seams ^d	6	8	15	10
Button problems	1	4	3	31
Trim problems	1	0	0	38
Shoulder pad problems	1	1	1	36
Stains or soil evaluation	3	5	10	21
Pressing acceptable	0	2	35	2
General appearance acceptable	1	3	32	4

^a These questions are not covered by an AATCC protocol.

^b WC - wetcleaned garment in pair.

^c DC - drycleaned garment in pair.

^d Category includes loose seams, fabric damage, and hanging or pulling threads.

Exhibit 6-24 contains data pertaining to the color change evaluation performed by the panel of evaluators. Color change was visible in both the wet and drycleaned garments (21 of 39). There was color change in 69% of all wetcleaned garments (27 of 39) and 62% of all drycleaned garments (24 of 39), indicating color change problems with both cleaning processes. Although color migration was not a large problem overall, the study notes that there seems to be a disproportionate amount associated with wetcleaning (four discordant pairs) when compared to drycleaning (one discordant pair).

Exhibit 6-24. Color Change Evaluation

Performance Quality	Discordant Pairs		Concordant Pairs	
	Yes - WC ^a No - DC ^b	No - WC Yes - DC	Yes - WC Yes - DC	No - WC No - DC
Visible color change	6	3	21	9
Visible color migration	4	1	2	32

^a WC - wetcleaned garment in pair.

^b DC - drycleaned garment in pair.

If color change or color migration was observed in garment pairs, the intensity of change and/or migration was quantified using the AATCC Gray Scale for Color Change rating and the AATCC Chromatic Transference Scale. Data for these tests are shown in Exhibit 6-25. Color change and migration were rated from 1 (maximum change) to 5 (no change). Color consistency and migration problems for wet and drycleaning were noted as comparable, although slightly higher (i.e., better) for wetcleaning. The average degree of color change for wetcleaned garments was 4.42 versus 4.55 for drycleaned garments; the average degree of color migration for wetcleaned garments was 3.63 versus 4.17 for drycleaned garments.

Exhibit 6-25. Gray Scale for Color Change and Chromatic Transference Scale for Color Migration

Cleaning Method	Number of Garments	Minimum	Maximum	Mean
Gray Scale for Color Change^a				
Wetcleaning	38	2.75	5.0	4.42
Drycleaning	38	1.75	5.0	4.55
Chromatic Transference Scale^a				
Wetcleaning	6	3.0	4.5	3.63
Drycleaning	3	4.0	4.5	4.17

^a Color change and chromatic transference scales range from 5 (no change) to 1 (maximum change).

Exhibit 6-26 contains the data from the odor evaluation. Evaluators made a slit in the plastic bag near the center of the front of the garment and inhaled through the hole. Odors were reported and described in detail. Overall, all odors were considered acceptable, although evaluators were able to detect some odor in practically all of the garments—81% of wetcleaned garments (32 of 39) and 95% of drycleaned garments (37 of 39). The study notes that more of the drycleaned garments had a chemical or “drycleaning” smell, and more of the wetcleaned garments smelled clean than those drycleaned.

Wearer Survey

A survey of 28 volunteer wearers who participated in the repeat clean test was used to assess whether the experience of wearing a wetcleaned garment differed from wearing an identical, drycleaned garment. Questions included reference to both positive qualities (e.g., cleanliness, satisfaction with pressing) and negative performance (e.g., shrinkage, discoloration). The results of this survey are found in Exhibit 6-27. Responses are divided into cases where the wearer was satisfied with one garment in the pair but not with the other (discordant pairs) and cases where the wearer was either satisfied or dissatisfied with both garments in the pair (concordant pairs).

The study notes that while not statistically significant, the results in Exhibit 6-27 indicate slightly more dissatisfaction with the pressing and shrinkage of wetcleaned garments. In addition, problems with discoloration, rips or tears, buttons, and garment feel were virtually the same for both wet and drycleaned garments.

Exhibit 6-26. Odor Evaluation

Performance Quality	Discordant Pairs		Concordant Pairs	
	Yes - WC ^a No - DC ^b	No - WC Yes - DC	Yes - WC Yes - DC	No - WC No - DC
Has odor	1	6	31	1
Smells clean	9	1	1	28
Smells like chemical	1	12	2	24
Smells like drycleaning	4	18	3	14
Odor unacceptable	0	0	39	0

^a WC = wetcleaned garment in pair.^b DC - drycleaned garment in pair.**Exhibit 6-27. Positive and Negative Performance Qualities: Distribution of Wearer Responses**

Performance Quality	Discordant Pairs		Concordant Pairs	
	Yes - WC ^a No - DC ^b	No - WC Yes - DC	Yes - WC Yes - DC	No - WC No - DC
Satisfied with pressing	1	3	33	2
Satisfied with stain removal	0	0	3	2
Satisfied with appearance	4	5	25	6
Shrinkage	3	1	1	35
Stretching	0	2	0	38
Discoloration	0	0	4	35
Feels worse	1	0	0	38
Rips or tears	2	2	1	35
Damaged buttons	2	1	0	37

^a WC - wetcleaned garment in pair.^b DC - drycleaned garment in pair.

Exhibit 6-28 includes the survey results for overall satisfaction with the wet and drycleaned garments worn by volunteers. The study notes that for most of the garments (60.6%), wearers responded

that they had no preference. Exhibit 6-29 contains survey results for preference of wearing wet and drycleaned garments. For those who did have a preference, twice as many seemed to prefer wetcleaned garments (69.2%) over drycleaned garments (30.8%).

Exhibit 6-28. Percent with Preference for Wearing One Garment Pair

Response	Frequency	Percent
Yes	13	33.3%
No	23	60.6%
Don't know	3	7.7%

Exhibit 6-29. Preference for Wearing Wetcleaned or Drycleaned Garments^a

Preference	Frequency	Percent
Wetcleaned garment	9	69.2%
Drycleaned garment	4	30.8%

^a Wearers did not know which garment was being wetcleaned and which drycleaned. The survey asked the wearer to write down the number associated with the specific garment for which they had a preference.

In summary, the study notes that wearers did not notice any significant difference between wet and drycleaned garments in shrinkage, stretching, pressing, color change, spot removal, odor, damage, or appearance. More wearers identified shrinkage and pressing problems associated with wetcleaned garments, while stretching problems were associated with drycleaned garments. In addition, twice as many wearers preferred wearing the garment that was wetcleaned over the garment that was drycleaned.

Customer Satisfaction Survey

Two telephone surveys were conducted to measure customer satisfaction, a key indicator of performance viability. The first telephone survey, directed toward customers who used *Cleaner by Nature* at least once, was used to measure satisfaction with and attitudes toward this professional cleaner. The second telephone survey was directed toward drycleaning customers who live in or near *Cleaner by Nature's* market area. The purpose of this second survey was to assist in evaluating the results of the *Cleaner by Nature* survey by comparing it with customers' satisfaction with drycleaning.

Cleaner by Nature Customers

Exhibit 6-30 summarizes the questions related to positive performance attributes that professional cleaners seek to maximize. The customer response rate to the *Cleaner by Nature* survey was 78% (180 surveys out of a total of 231 contacts). Exhibit 6-31 summarizes the responses to questions related to

negative performance attributes that professional cleaners seek to minimize. The study notes that more than three quarters of the customers reported that their garments were always clean and that they were always satisfied with how the garments were pressed. Fewer than half the customers who brought garments to *Cleaner by Nature* with spots or stains said they were always removed to their satisfaction. However, 78.6% of all customers were always or frequently satisfied with stain removal. Over 80% of *Cleaner by Nature* customers interviewed reported never experiencing any shrinkage, stretching, change in color, change in feel, bad odors, rips or tears, or damage to buttons or decorations. Shrinkage was the most common problem reported, with more than 15% of customers interviewed having shrinkage in the garment cleaned by *Cleaner by Nature*.

Exhibit 6-30. Positive Performance Qualities Experienced by *Cleaner by Nature* Customers

Performance Quality	Always	Frequently	Sometimes	Never
Clean	88.4%	8.1%	2.3%	1.2%
Satisfied with pressing	75.8%	15.2%	6.1%	3.0%
Satisfied with stain removal	47.5%	31.1%	13.9%	7.4%

Exhibit 6-31. Negative Performance Qualities Experienced by *Cleaner by Nature* Customers

Performance Quality	Never	Sometimes	Frequently	Always
Shrinkage	84.1%	12.9%	1.8%	1.2%
Stretching	92.9%	6.0%	0.6%	0.6%
Change in color	92.3%	4.7%	2.4%	0.6%
Change in feel	88.7%	9.4%	1.3%	0.7%
Odor	94.1%	3.6%	0.0%	2.4%
Rips or tears	95.9%	4.1%	0.0%	0.0%
Damage to buttons or decorations	95.7%	3.6%	0.7%	0.0%

The study notes that if each of the 10 performance measures in Exhibits 6-30 and 6-31 is treated individually, there appears to be a high level of satisfaction with how customers' garments were treated. Stain removal was noted as the largest problem: over half of surveyed customers with spotted or stained garments noted that the spots or stains were not always removed to their satisfaction. Other problems noted included shrinkage (15% of customers) and pressing (25% of customers). Collectively, half of all customers (91 of 180) reported having at least one of the performance problems noted in Exhibit 6-31, yet only half of these customers reported that they had experienced a "problem" with the garment as a result of sending it to *Cleaner by Nature*.

Exhibit 6-32 contains the results of customer rating of *Cleaner by Nature*. More than 60% of the 180 customers surveyed reported *Cleaner by Nature* as an excellent professional cleaner, 32.4% rated it as good, 4.6% rated it as fair, and 2.3% rated it as poor. These data are highly correlated with whether or not customers would recommend *Cleaner by Nature* to friend: all but 4 of the 161 customers interviewed who rated *Cleaner by Nature* as excellent or good also would recommend it to a friend, while 3 of the 12 customers rating it as fair to poor would recommend it to a friend. In addition, 77.8% of the customers surveyed said they were still customers of *Cleaner by Nature*.

Exhibit 6-32. Customer Rating of *Cleaner by Nature* as a Professional Cleaner

Rating	Frequency	Percent
Excellent	105	60.7%
Good	56	32.4%
Fair	8	4.6%
Poor	4	2.3%

Of the 39 customers who stopped using *Cleaner by Nature*, 41% noted that location was the reason why they stopped. Other reasons for not using *Cleaner by Nature* included dissatisfaction with cleaning quality (23.1%), price (20.5%), and service or convenience (15.4%). The study notes that nearly 65% of *Cleaner by Nature* customers use it exclusively, while the remaining 35% still use a drycleaner also. Three quarters of these customers take fewer than 25% of their garments to the drycleaner. The reasons for continuing to use a drycleaner, in addition to *Cleaner by Nature*, include location/convenience (43.9%), cleaning quality (29.3%), price (14.6%), and turnaround time (12.2%).

A customer comparison of *Cleaner by Nature* customers who still used a local drycleaner was also performed for this survey. All customers interviewed mentioned that they had used drycleaning in the past. When asked to state which operation was better for the environment, all customers stated that *Cleaner by Nature* was better. In terms of cost, 37% of customers said drycleaning was lower, 22% said *Cleaner by Nature* was lower, 28% said prices were equivalent, and 13% said it depended on the individual cleaner. *Cleaner by Nature* customers rated the quality of cleaning for that operation to be higher than drycleaning 73% of the time (compared to 5.8% for drycleaning) and rated the quality as the same 20.6% of the time. In addition, nearly 86% of customers were more satisfied, overall, with *Cleaner by Nature*, compared to 10.3% of customers being more satisfied with drycleaning. The remaining 4% of customers were equally satisfied with dry and wetcleaning results.

Drycleaning Customers

A survey of customers of drycleaners, conducted in May 1997, was performed to provide a baseline for analysis of the *Cleaner by Nature* customer satisfaction survey. The customer response rate to the dryclean survey was 36% (100 surveys out of a total of 250 contacts). Exhibit 6-33 summarizes how experienced *Cleaner by Nature* customers and drycleaning customers responded to questions relating to three positive performance qualities that professional cleaners seek to maximize. The study notes that while

over 96% of *Cleaner by Nature* customers reported their garments as clean, only 79% of drycleaning customers reported the same. While satisfaction with garment pressing was similar (89.6% for *Cleaner by Nature*; 83.8% for drycleaning), fewer than 50% of the drycleaning customers expressed satisfaction with stain removal, versus nearly 80% for *Cleaner by Nature* customers.

Exhibit 6-33. Positive Performance Qualities Experienced by *Cleaner by Nature* Customers and DryCleaner Customers^a

Performance Quality	Professional Cleaner	Frequently or Always	Never, Rarely, ^b or Sometimes
Clean	<i>Cleaner by Nature</i> Drycleaning	96.2% 79.0%	3.80% 19.0%
Pressing	<i>Cleaner by Nature</i> Drycleaning	89.6% 83.8%	10.4% 16.2%
Stain removal	<i>Cleaner by Nature</i> Drycleaning	79.7% 49.0%	20.3% 51.0%

^a *Cleaner by Nature* customers with six or more transactions.

^b Only drycleaning customers were asked whether these performance attributes occurred rarely.

Exhibit 6-34 summarizes how repeat *Cleaner by Nature* customers and drycleaning customers responded on seven negative performance qualities that professional cleaners seek to minimize. Based on the data from this table, shrinkage, stretching, and rips and tears in garments are reported similarly for both cleaning methods. The study notes that drycleaning customers reported significantly more problems with changes in the color or feel of garments, damage to buttons or decorations, and odor, compared with wetcleaning customers.

In terms of overall customer satisfaction with the cleaning process, 91.1% of *Cleaner by Nature* customers provided an excellent or good rating, versus 86.6% for drycleaning. In addition, 93.2% of *Cleaner by Nature* customers said they would recommend the cleaner to a friend, versus 87.7% of drycleaning customers. The study also reports that 54.0% of drycleaning customers have stopped using a professional cleaner in the last year, while only 22.7% of all *Cleaner by Nature* customers reported that they were no longer using *Cleaner by Nature*.

Exhibit 6-34. Negative Performance Qualities Experienced by *Cleaner by Nature* Customers and Drycleaning Customers^a

Performance Quality	Professional Cleaner	Rarely or Never ^b	Sometimes, Frequently, or Always
Shrinkage	<i>Cleaner by Nature</i> Drycleaning	74.0% 81.0%	26.0% 19.0%
Stretching	<i>Cleaner by Nature</i> Drycleaning	86.8% 86.0%	13.2% 14.0%
Rips or tears	<i>Cleaner by Nature</i> Drycleaning	91.0% 89.0%	9.0% 11.0%
Color change	<i>Cleaner by Nature</i> Drycleaning	90.4% 79.0%	9.6% 21.0%
Change in feel	<i>Cleaner by Nature</i> Drycleaning	83.1% 66.3%	12.9% 33.7%
Damage to buttons ^c	<i>Cleaner by Nature</i> Drycleaning	96.1% 63.0%	3.9% 37.0%
Unpleasant odor	<i>Cleaner by Nature</i> Drycleaning	100.0% 72.7%	0.0% 28.3%

^a *Cleaner by Nature* customers with six or more transactions.

^b Only drycleaning customers were asked whether performance attributes occurred rarely.

^c This category also includes damage to decorations.

Exhibit 6-35 shows the distribution of reasons why customers stopped using a professional cleaner. The proportion of *Cleaner by Nature* customers citing quality of cleaning or price as the primary reason they stopped using this wetcleaner is similar to the proportion of drycleaning customers who also listed these as their primary reason. The study also notes that twice as many *Cleaner by Nature* customers mentioned location as the primary reason for discontinuing use of the wetcleaner, while almost twice as many drycleaning customers mentioned service and convenience.

Exhibit 6-35. Primary Reason Customers Stopped Using Professional Cleaner: A Comparison of *Cleaner by Nature* and Drycleaning Customers^a

Professional Cleaner	Location	Quality of Cleaning	Price	Service/Convenience
<i>Cleaner by Nature</i> ^a	42.9%	28.6%	14.3%	14.3%
Drycleaning	23.5%	35.3%	15.7%	25.5%

^a Includes all *Cleaner by Nature* customers.

Performance Assessment Conclusions

The *Cleaner by Nature* study concludes that it is possible for all garments brought in by customers, including those labeled “dryclean only,” to be wetcleaned. The researchers note that, overall, *Cleaner by Nature* was comparable to a drycleaner in terms of the magnitude of problems identified through the cleaning performance evaluation. Problem areas that were identified for wetcleaning included color change, shrinkage, and pressing, while problem areas associated with drycleaning operations included stain removal, garment damage, and stretching. The study also mentions a high level of satisfaction with *Cleaner by Nature* overall, continual growth of its customer base, and a high retention rate of customers.

6.2.5 Alternative Textile Care Technologies: Part I

Sponsor:	USEPA, Office of Research and Development
Investigating Organization:	Texas Woman’s University, Department of Fashion and Textiles
Principal Investigator:	Dr. Charles Riggs
Duration:	3 years (currently funded for 1 year)
Location:	Houston, Texas
Source of Information:	Riggs, 1996

Summary of Performance Evaluations

This study is assessing the performance of alternative technologies. Researchers hope to gather data using machine wetcleaning, PCE drycleaning, HC solvent drycleaning (Exxon’s DF-2000), and potentially liquid CO₂ technology. The scope of this study is limited to soil and fabric combinations that are problem areas for the cleaning industry.

Performance Evaluations

- Identification of “problem” soil and fabric combinations for alternative clothes cleaning technologies
- Development of a methodology to evaluate the cleaning performance of alternative technologies
- Work with North Carolina State University to develop consensus procedures for evaluating clothes cleaning technology

Experimental Technology

- Unimac wetcleaning machine (Model UA230) with Seitz chemicals
- Aquatex drying cabinet
- Boewe-Passat, Permac PCE drycleaning machine (P546 - 46 lb)
- Boewe-Passat, Permac DF-2000 HC drycleaning machine
- Liquid CO₂ cleaning technology (may not be available for test)

6.2.6 Alternative Textile Care Technologies: Part II

Sponsor:	USEPA, Office of Research and Development
Investigating Organization:	North Carolina State University, College of Textiles
Principal Investigator:	Dr. Perry Grady
Duration of Study:	3 years (currently funded for 1 year)
Location:	Raleigh, North Carolina
Source of Information:	Grady, 1996

Summary of Performance Evaluations

This study focuses on testing and developing alternative cleaning technologies to reduce indoor air emissions from PCE drycleaning and drycleaned fabrics. Currently, the project is studying the effectiveness of “piggy backing” ultrasonic cleaning technology with current wet and drycleaning methods. Additional work is planned with a bench scale apparatus for liquid CO₂ cleaning technology. Fabric and soil samples will be used in cooperation with the investigation in Part I (Section 6.2.5). The goal of this exploratory study is to develop a cleaning system that removes complex soils and eliminates the use of non-aqueous solvents.

Performance Evaluations

Ultrasound and, possibly, liquid CO₂ technologies will be used in tandem with machine wetcleaning, traditional PCE drycleaning, and HC solvent drycleaning systems.

Preliminary Test Results

Ultrasound assists solvent soil removal with compatible soils (i.e., oil-based). In terms of water-based cleaning, ultrasound technology reduces the need for mechanical agitation, decreasing the amount of shrinkage in garments. It may also reduce the temperature and mechanical agitation necessary for non-aqueous-based clothes cleaning methods.

6.2.7 University of Guelph Fabric Swatch Study

Sponsor:	Environment Canada
Investigating Organization:	University of Guelph, Textile Sciences Group
Principal Investigator:	Anne Wilcock
Location:	Guelph, ONT, Canada
Duration:	Unknown
Source of Information:	Wilcock, 1996

Summary of Performance Evaluations

The data obtained from this study have not been analyzed in total due to a lack of research funding. Environment Canada has used selective parts of the data to support the previously mentioned Green Clean study (Section 6.2.3). Most of the data generated by the principal investigator remain unpublished and unanalyzed at this time.

Performance Evaluations

Six cleaning processes (pressing only, steam cleaning, drycleaning in PCE, “green cleaning,” machine wetcleaning, and home laundering) were used for comparison in this study. Textile swatches included undyed/unfinished fabrics, dyed/finished fabrics, fused fabrics, and whole garments. Within each category, 4 to 13 different fabrics were cleaned, representing an array of weights, fiber mixtures, and constructions likely to be encountered in day-to-day business. The data obtained from these cleaning trials have not yet been completely analyzed.

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